Class10: Halloween mini project

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Background

As it is nearly Halloween and the half way point in the quarter let's do a mini project that help us figure out the best candy!

Our data come from the 538 website and is available as a CSV file:

Data Export

```r
candy <- read.csv("candy-data.txt", row.names = 1)
head(candy)
```

```
             chocolate fruity caramel peanutyalmondy nougat crispedricewafer
100 Grand            1      0       1              0      0                1
3 Musketeers         1      0       0              0      1                0
One dime             0      0       0              0      0                0
One quarter          0      0       0              0      0                0
Air Heads            0      1       0              0      0                0
Almond Joy           1      0       0              1      0                0
```

```
               hard bar pluribus sugarpercent pricepercent winpercent
100 Grand         0   1        0        0.732        0.860   66.97173
3 Musketeers      0   1        0        0.604        0.511   67.60294
One dime          0   0        0        0.011        0.116   32.26109
One quarter       0   0        0        0.011        0.511   46.11650
Air Heads         0   0        0        0.906        0.511   52.34146
Almond Joy        0   1        0        0.465        0.767   50.34755
```

```
library(flextable)
flextable::flextable(head(candy, 10))
```

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	s
1	0	1	0	0	1	0	1	0	
1	0	0	0	1	0	0	1	0	
0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	0	
1	0	1	1	1	0	0	1	0	
0	0	0	1	0	0	0	0	1	
0	0	0	0	0	0	0	0	1	
0	1	1	0	0	0	0	0	0	

Q1. How many different candy types are in this dataset?

```
nrow(candy)
```

```
[1] 85
```

```
candy |>
  nrow()
```

```
[1] 85
```

```r
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.1     v stringr   1.5.2
v ggplot2   4.0.0     v tibble    3.3.0
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.1.0
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x purrr::compose() masks flextable::compose()
x dplyr::filter()  masks stats::filter()
x dplyr::lag()     masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becon
```

```r
candy %>%
  nrow()
```

```
[1] 85
```

Q2. How many fruity candy types are in the dataset?

```r
sum(candy$fruity)
```

```
[1] 38
```

My favorite winpercent

```r
library(dplyr)

candy |>
  filter(rownames(candy) == "Almond Joy") |>
  select(winpercent)
```

```
           winpercent
Almond Joy   50.34755
```

```r
candy["Twix", ]$winpercent
```

```
[1] 81.64291
```

Q3. What is your favorite candy in the dataset and what is it's winpercent value?

```
candy["Air Head", ]$winpercent
```

```
[1] 52.34146
```

Q4. What is the winpercent value for "Kit Kat"?

```
candy["Kit Kat", ]$winpercent
```

```
[1] 76.7686
```

Q5. What is the winpercent value for "Tootsie Roll Snack Bars"?

```
candy["Toostie Roll Snack Bars", ]$winpercent
```

```
[1] NA
```

Quick overview of the dataset

```
library("skimr")
skimr::skim(candy)
```

Table 2: Data summary

Name	candy
Number of rows	85
Number of columns	12
Column type frequency:	
numeric	12
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
chocolate	0	1	0.44	0.50	0.00	0.00	0.00	1.00	1.00	
fruity	0	1	0.45	0.50	0.00	0.00	0.00	1.00	1.00	
caramel	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
peanutyalmondy	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
nougat	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
crispedricewafer	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
hard	0	1	0.18	0.38	0.00	0.00	0.00	0.00	1.00	
bar	0	1	0.25	0.43	0.00	0.00	0.00	0.00	1.00	
pluribus	0	1	0.52	0.50	0.00	0.00	1.00	1.00	1.00	
sugarpercent	0	1	0.48	0.28	0.01	0.22	0.47	0.73	0.99	
pricepercent	0	1	0.47	0.29	0.01	0.26	0.47	0.65	0.98	
winpercent	0	1	50.32	14.71	22.45	39.14	47.83	59.86	84.18	

> Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset?

The winpercent is on a 0-100 scale the rest are 0-1 scale

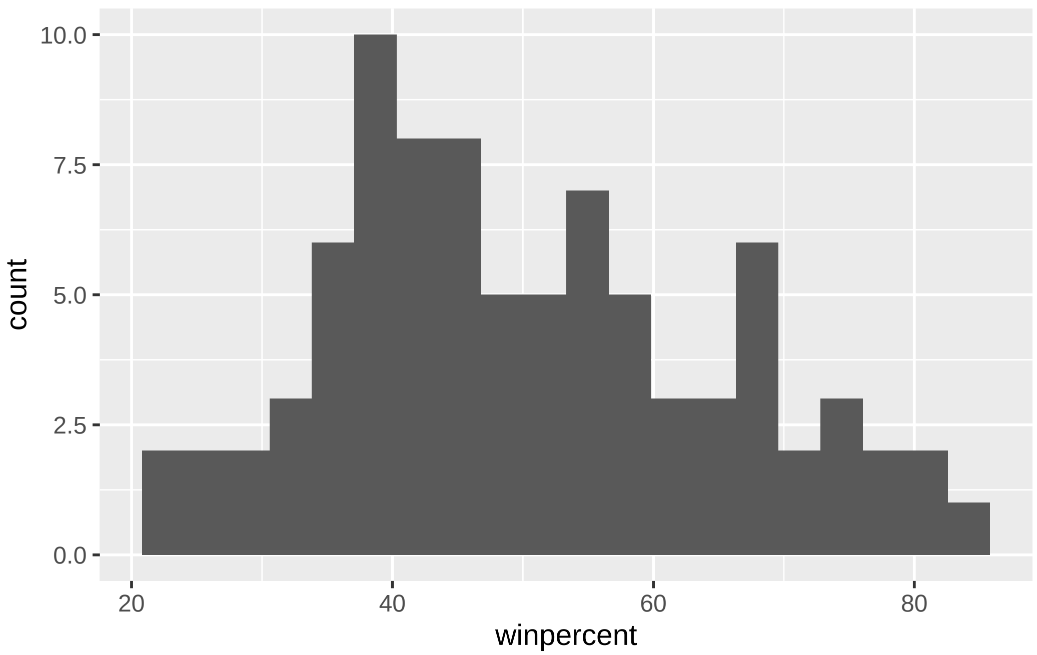
> Q7. What do you think a zero and one represent for the candy$chocolate column?

That the candy does not contain chocolate

> Q8. Plot a histogram of winpercent values

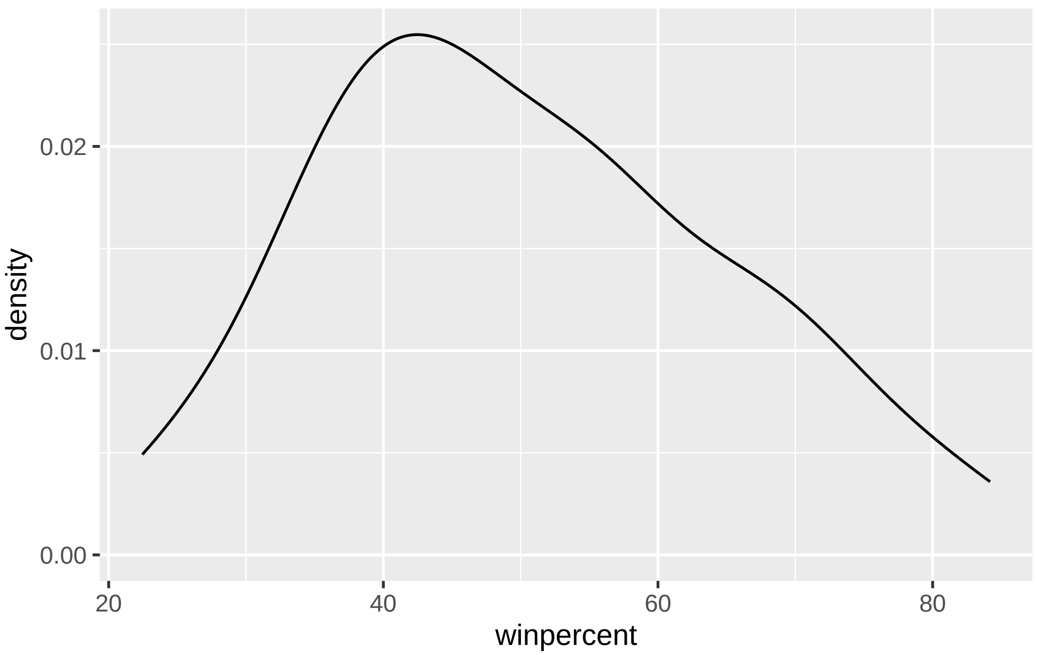
```r
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins = 20)
```



Q9. Is the distribution of winpercent values symmetrical?

```
ggplot(candy) +
  aes(winpercent) +
  geom_density()
```



Q10. Is the center of the distribution above or below 50%?

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

```
summary(candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.14   47.83   50.32   59.86   84.18 
```

Q11. On average is chocolate candy higher or lower ranked than fruit candy?

```
# 1. Find all chocolate candy in the data set
# 2. Find their winpercent values
# 3. Calculate the mean of these values

# 4-6. Do the same for fruity candy
# 7. Compare mean winpercents of chocolate vs fruity
# 8. Pick the highest as the winner

choc.inds <- candy$chocolate == 1
```

```r
choc.win <- candy[choc.inds, ]$winpercent
choc.mean <- mean(choc.win)
choc.mean
```

```
[1] 60.92153
```

```r
mean(candy[candy$chocolate==1,]$winpercent)
```

```
[1] 60.92153
```

```r
mean(candy[candy$fruity==1,]$winpercent)
```

```
[1] 44.11974
```

```r
frut.ind <- candy$fruity==1
frut.win <- candy[frut.ind,]$winpercent
frut.mean <- mean(frut.win)
frut.mean
```

```
[1] 44.11974
```

```r
candy |>
  filter(chocolate==1) |>
  select(winpercent)
```

```
                            winpercent
100 Grand                     66.97173
3 Musketeers                  67.60294
Almond Joy                    50.34755
Baby Ruth                     56.91455
Charleston Chew               38.97504
Hershey's Kisses              55.37545
Hershey's Krackel             62.28448
Hershey's Milk Chocolate      56.49050
Hershey's Special Dark        59.23612
Junior Mints                  57.21925
Kit Kat                       76.76860
Peanut butter M&M's           71.46505
```

```
M&M's                          66.57458
Milk Duds                      55.06407
Milky Way                      73.09956
Milky Way Midnight             60.80070
Milky Way Simply Caramel       64.35334
Mounds                         47.82975
Mr Good Bar                    54.52645
Nestle Butterfinger            70.73564
Nestle Crunch                  66.47068
Peanut M&Ms                    69.48379
Reese's Miniatures             81.86626
Reese's Peanut Butter cup      84.18029
Reese's pieces                 73.43499
Reese's stuffed with pieces    72.88790
Rolo                           65.71629
Sixlets                        34.72200
Nestle Smarties                37.88719
Snickers                       76.67378
Snickers Crisper               59.52925
Tootsie Pop                    48.98265
Tootsie Roll Juniors           43.06890
Tootsie Roll Midgies           45.73675
Tootsie Roll Snack Bars        49.65350
Twix                           81.64291
Whoppers                       49.52411
```

Q12. Is this difference statistically significant?

```
t.test(choc.win, frut.win)
```

```

    Welch Two Sample t-test

data:  choc.win and frut.win
t = 6.2582, df = 68.882, p-value = 2.871e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.44563 22.15795
sample estimates:
mean of x mean of y 
 60.92153  44.11974 
```

Overall Candy Ranking

Q13. What are the five least liked candy types in this set?

```
candy |>
  arrange(winpercent) |>
  head(5)
```

```
                   chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                  0      1       0              0      0
Boston Baked Beans         0      0       0              1      0
Chiclets                   0      1       0              0      0
Super Bubble               0      1       0              0      0
Jawbusters                 0      1       0              0      0
                   crispedricewafer hard bar pluribus sugarpercent pricepercent
Nik L Nip                         0    0   0        1        0.197        0.976
Boston Baked Beans                0    0   0        1        0.313        0.511
Chiclets                          0    0   0        1        0.046        0.325
Super Bubble                      0    0   0        0        0.162        0.116
Jawbusters                        0    1   0        1        0.093        0.511
                   winpercent
Nik L Nip            22.44534
Boston Baked Beans   23.41782
Chiclets             24.52499
Super Bubble         27.30386
Jawbusters           28.12744
```

```
x <- c(5,1,10,4)
#sort(x)
order(x)
```

```
[1] 2 4 1 3
```

```
#order(candy$winpercent)
```

```
ord.ind <- order(candy$winpercent)
head(candy[ord.ind,], 5)
```

```
                   chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                  0      1       0              0      0
```

```
Boston Baked Beans         0      0       0              1      0
Chiclets                   0      1       0              0      0
Super Bubble               0      1       0              0      0
Jawbusters                 0      1       0              0      0
                   crispedricewafer hard bar pluribus sugarpercent pricepercent
Nik L Nip                         0    0   0        1        0.197        0.976
Boston Baked Beans                0    0   0        1        0.313        0.511
Chiclets                          0    0   0        1        0.046        0.325
Super Bubble                      0    0   0        0        0.162        0.116
Jawbusters                        0    1   0        1        0.093        0.511
                   winpercent
Nik L Nip            22.44534
Boston Baked Beans   23.41782
Chiclets             24.52499
Super Bubble         27.30386
Jawbusters           28.12744
```

Q14. What are the top 5 all time favorite candy types out of this set?

```
candy |>
  arrange(winpercent) |>
  tail(5)
```

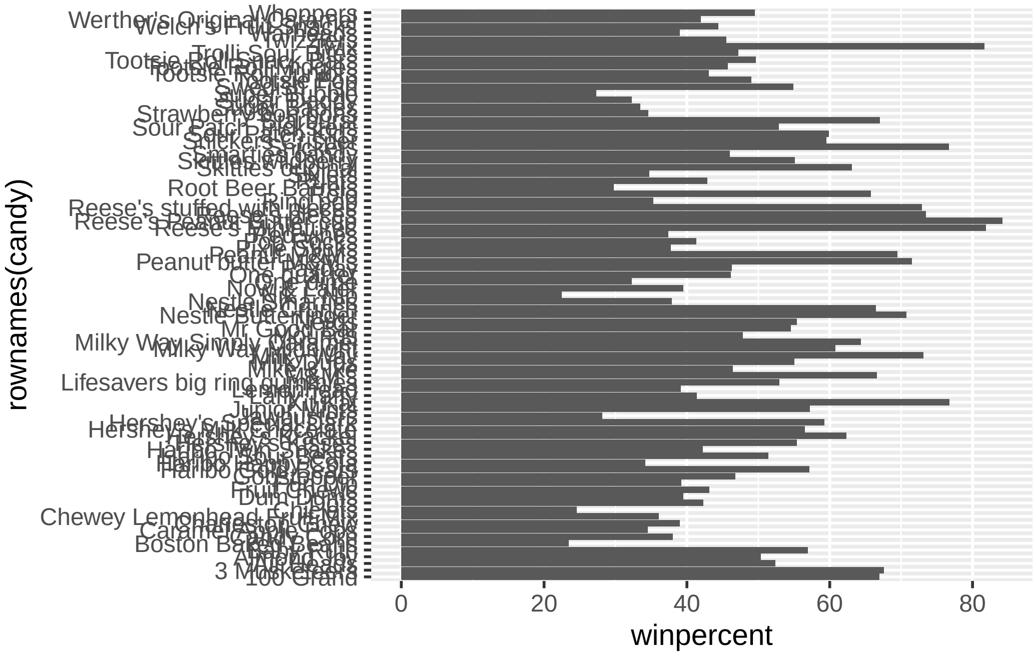
```
                          chocolate fruity caramel peanutyalmondy nougat
Snickers                          1      0       1              1      1
Kit Kat                           1      0       0              0      0
Twix                              1      0       1              0      0
Reese's Miniatures                1      0       0              1      0
Reese's Peanut Butter cup         1      0       0              1      0
                          crispedricewafer hard bar pluribus sugarpercent
Snickers                                 0    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Twix                                     1    0   1        0        0.546
Reese's Miniatures                       0    0   0        0        0.034
Reese's Peanut Butter cup                0    0   0        0        0.720
                          pricepercent winpercent
Snickers                         0.651   76.67378
Kit Kat                          0.511   76.76860
Twix                             0.906   81.64291
Reese's Miniatures               0.279   81.86626
Reese's Peanut Butter cup        0.651   84.18029
```

```
candy |>
  arrange(-winpercent) |>
  head(5)
```

```
                          chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           1      0       0              0      0
Snickers                          1      0       1              1      1
                          crispedricewafer hard bar pluribus sugarpercent
Reese's Peanut Butter cup                0    0   0        0        0.720
Reese's Miniatures                       0    0   0        0        0.034
Twix                                     1    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Snickers                                 0    0   1        0        0.546
                          pricepercent winpercent
Reese's Peanut Butter cup        0.651   84.18029
Reese's Miniatures               0.279   81.86626
Twix                             0.906   81.64291
Kit Kat                          0.511   76.76860
Snickers                         0.651   76.67378
```

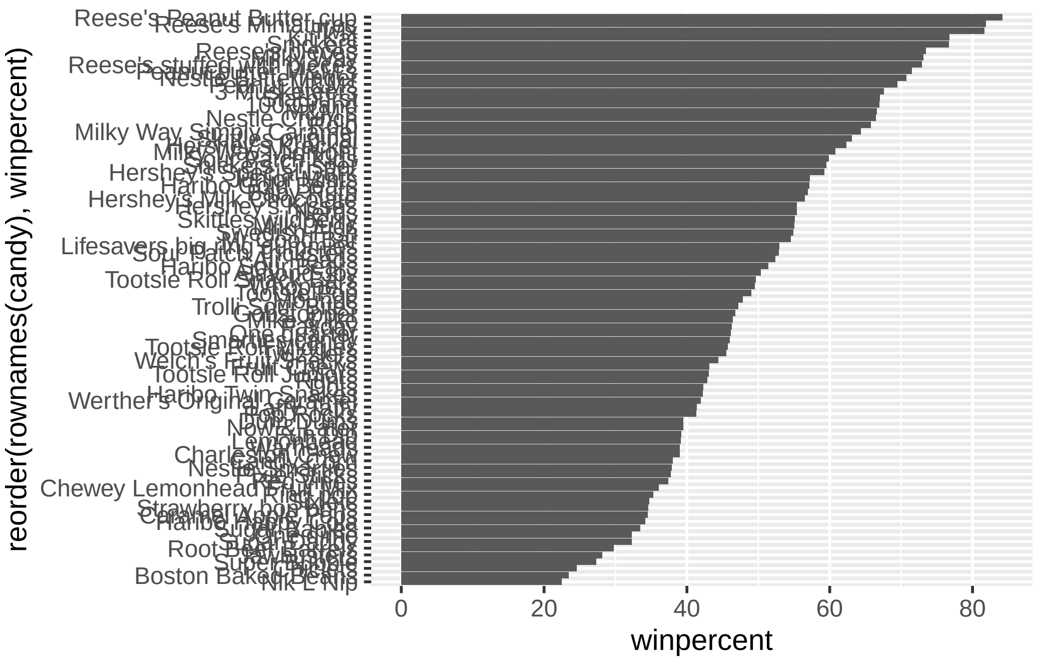
Q15. Make a first barplot of candy ranking based on winpercent values.

```
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```



Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```r
ggplot(candy) +
  aes(x = winpercent,
      y = reorder(rownames(candy), winpercent)) +
  geom_col()
```

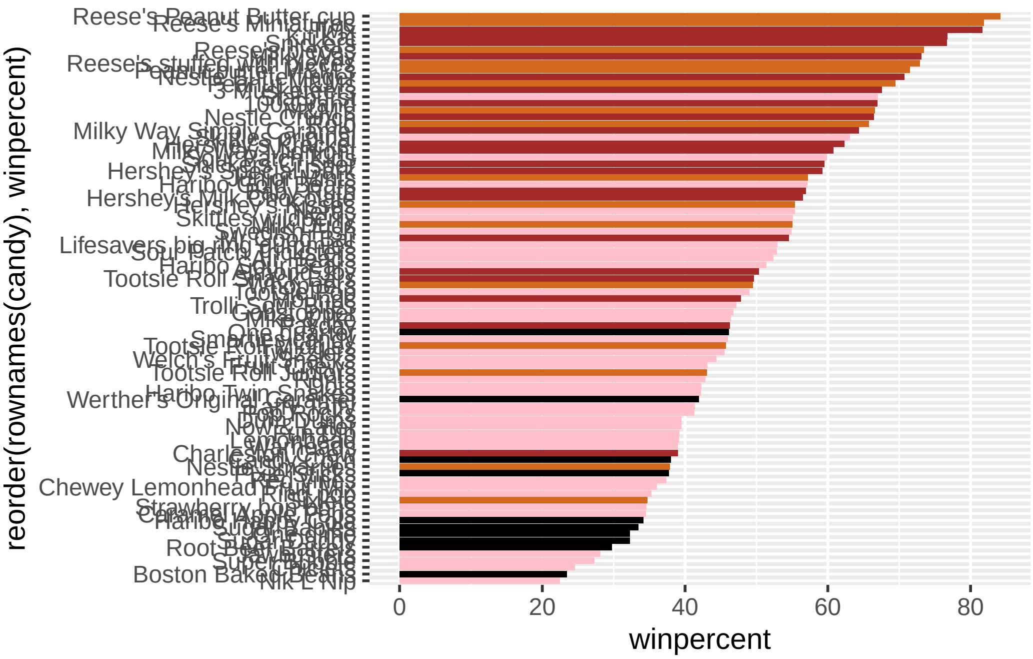


Add some color based on the "type" of candy

```
my_cols <- rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$fruity)] <- "pink"
my_cols[as.logical(candy$bar)] <- "brown"
my_cols
```

```
 [1] "brown"     "brown"     "black"     "black"     "pink"      "brown"    
 [7] "brown"     "black"     "black"     "pink"      "brown"     "pink"     
[13] "pink"      "pink"      "pink"      "pink"      "pink"      "pink"     
[19] "pink"      "black"     "pink"      "pink"      "chocolate" "brown"    
[25] "brown"     "brown"     "pink"      "chocolate" "brown"     "pink"     
[31] "pink"      "pink"      "chocolate" "chocolate" "pink"      "chocolate"
[37] "brown"     "brown"     "brown"     "brown"     "brown"     "pink"     
[43] "brown"     "brown"     "pink"      "pink"      "brown"     "chocolate"
[49] "black"     "pink"      "pink"      "chocolate" "chocolate" "chocolate"
[55] "chocolate" "pink"      "chocolate" "black"     "pink"      "chocolate"
[61] "pink"      "pink"      "chocolate" "pink"      "brown"     "brown"    
[67] "pink"      "pink"      "pink"      "pink"      "black"     "black"    
[73] "pink"      "pink"      "pink"      "chocolate" "chocolate" "brown"    
[79] "pink"      "brown"     "pink"      "pink"      "pink"      "black"    
[85] "chocolate"
```

```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill=my_cols)
```



Q17. What is the worst ranked chocolate candy?

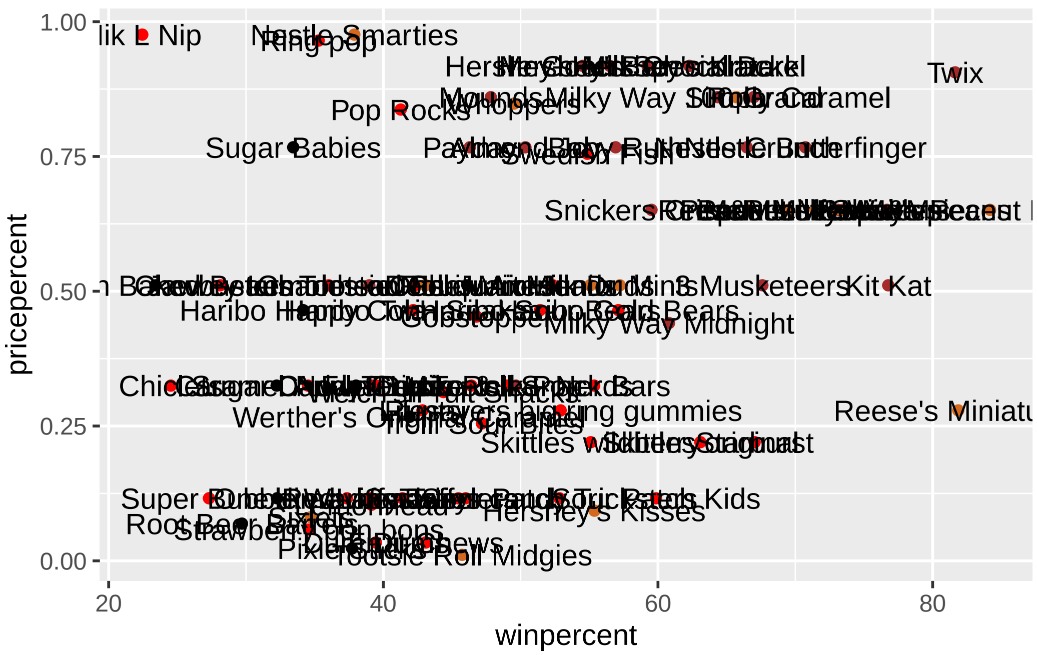
Sixlets >Q18. What is the best ranked fruity candy?

Starburst

Winpercent and Pricepercent

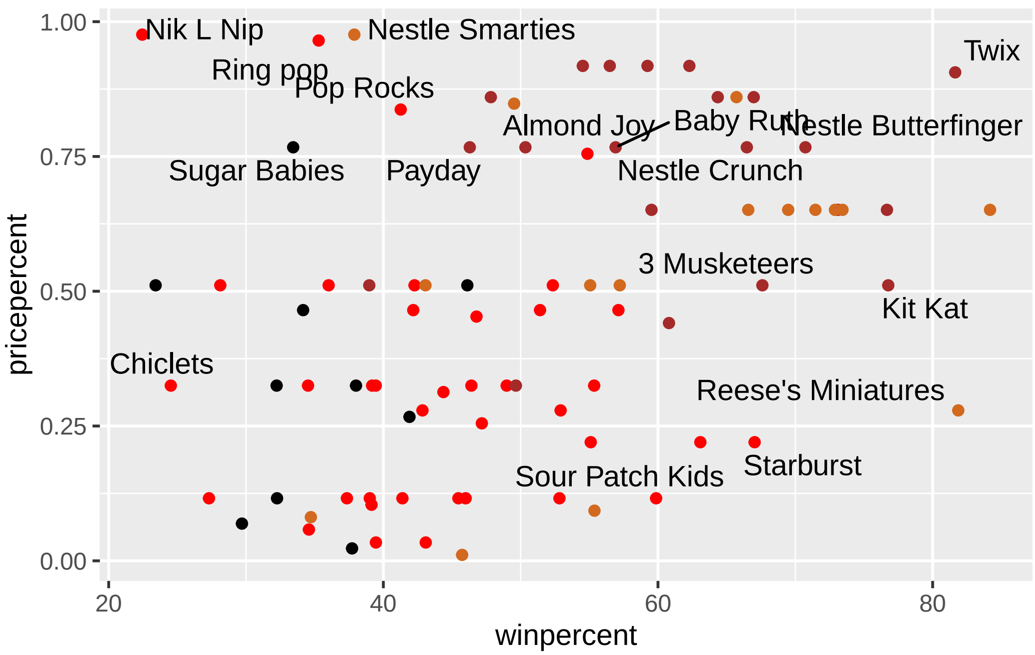
A plot with both variables/columns winpercent and pricepercent

```
my_cols[as.logical(candy$fruity)] <- "red"
ggplot(candy) +
  aes(x = winpercent,
      y = pricepercent,
      label = rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text()
```



```r
library(ggrepel)
my_cols[as.logical(candy$fruity)] <- "red"
ggplot(candy) +
  aes(x = winpercent,
      y = pricepercent,
      label = rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(max.overlaps = 7)
```

```
Warning: ggrepel: 68 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



> Q19. Which candy type is the highest ranked in terms of winpercent for the least money - i.e. offers the most bang for your buck?

Reese's Miniatures > Q20. What are the top 5 most expensive candy types in the dataset and of these which is the least popular?

```
ord <- order(candy$pricepercent, decreasing = TRUE)
head(candy[ord, c(1, 11, 12)], n = 5)
```

```
                          chocolate pricepercent winpercent
Nik L Nip                         0        0.976   22.44534
Nestle Smarties                   1        0.976   37.88719
Ring pop                          0        0.965   35.29076
Hershey's Krackel                 1        0.918   62.28448
Hershey's Milk Chocolate          1        0.918   56.49050
```

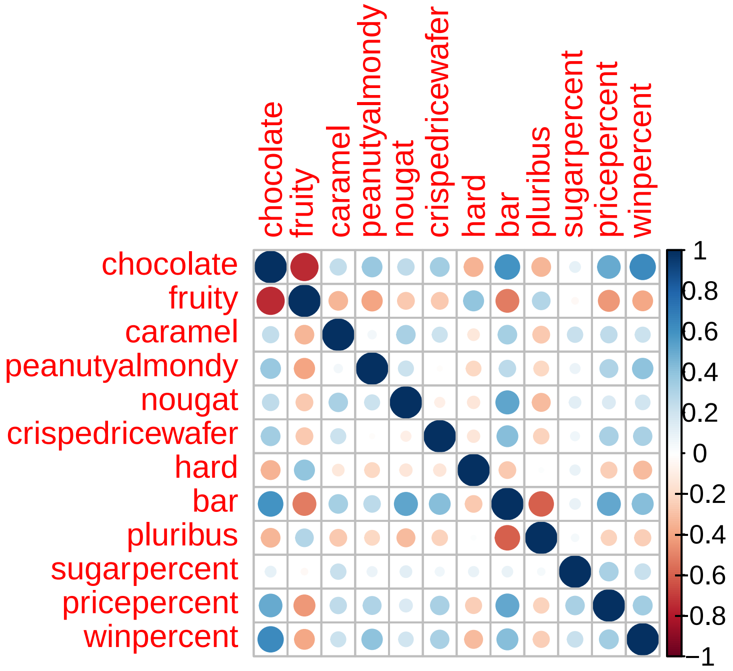
Exploring the correlation structure

Now that we've explored the dataset a little, we'll see how the variables interact with one another. We'll use correlation and view the results with the corrplot package to plot a correlation matrix.

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
cij <- cor(candy)
corrplot(cij)
```



> Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)?

fruity and chocolate > Q23. Similarly, what two variables are most positively correlated?

winpercent and chocolate

Principal Component Analysis

The function to use is called `prcomp()` with an optional `scale=T/F` argument.

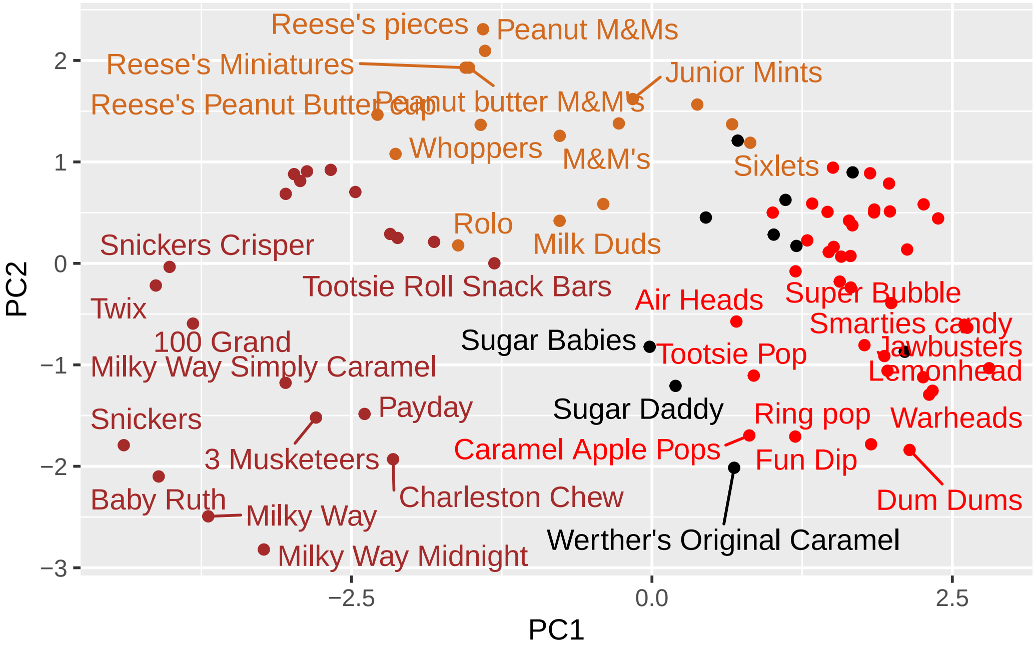
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 0.7424 0.79830 0.85369
                           PC8     PC9    PC10    PC11    PC12
Standard deviation     0.74530 0.67824 0.62349 0.43974 0.39760
Proportion of Variance 0.04629 0.03833 0.03239 0.01611 0.01317
Cumulative Proportion  0.89998 0.93832 0.97071 0.98683 1.00000
```

Our main PCA result figure

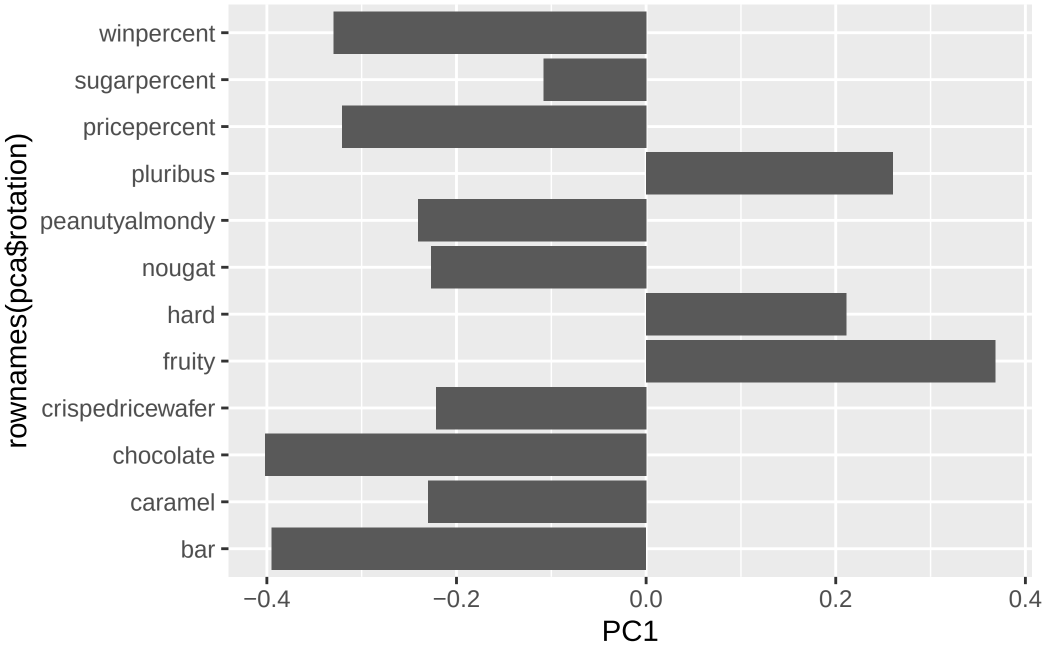
```
ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col = my_cols) +
  geom_text_repel(col = my_cols)
```

```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



We should also examine the variable "loading" or contributions of the original variables to the new PCs

```r
ggplot(pca$rotation) +
  aes(PC1, rownames(pca$rotation)) +
  geom_col()
```



```r
p <- ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col = my_cols) +
  geom_text_repel(col = my_cols)
```

Interactive plots that can be zoomed on and "brushed" over can be made with the **plotly** package. Its output is interactive and will not render to PDF :-(

```r
library(plotly)
```

```
Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

    last_plot
```

```
The following objects are masked from 'package:flextable':

    highlight, style


The following object is masked from 'package:stats':

    filter


The following object is masked from 'package:graphics':

    layout
```

```
#ggplotly(p)
```

> Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you?

PC1 picked up “fruity”, “hard”, “pluribus” in the positive direction. It makes sense as it picks up candies that fall into these categories.